

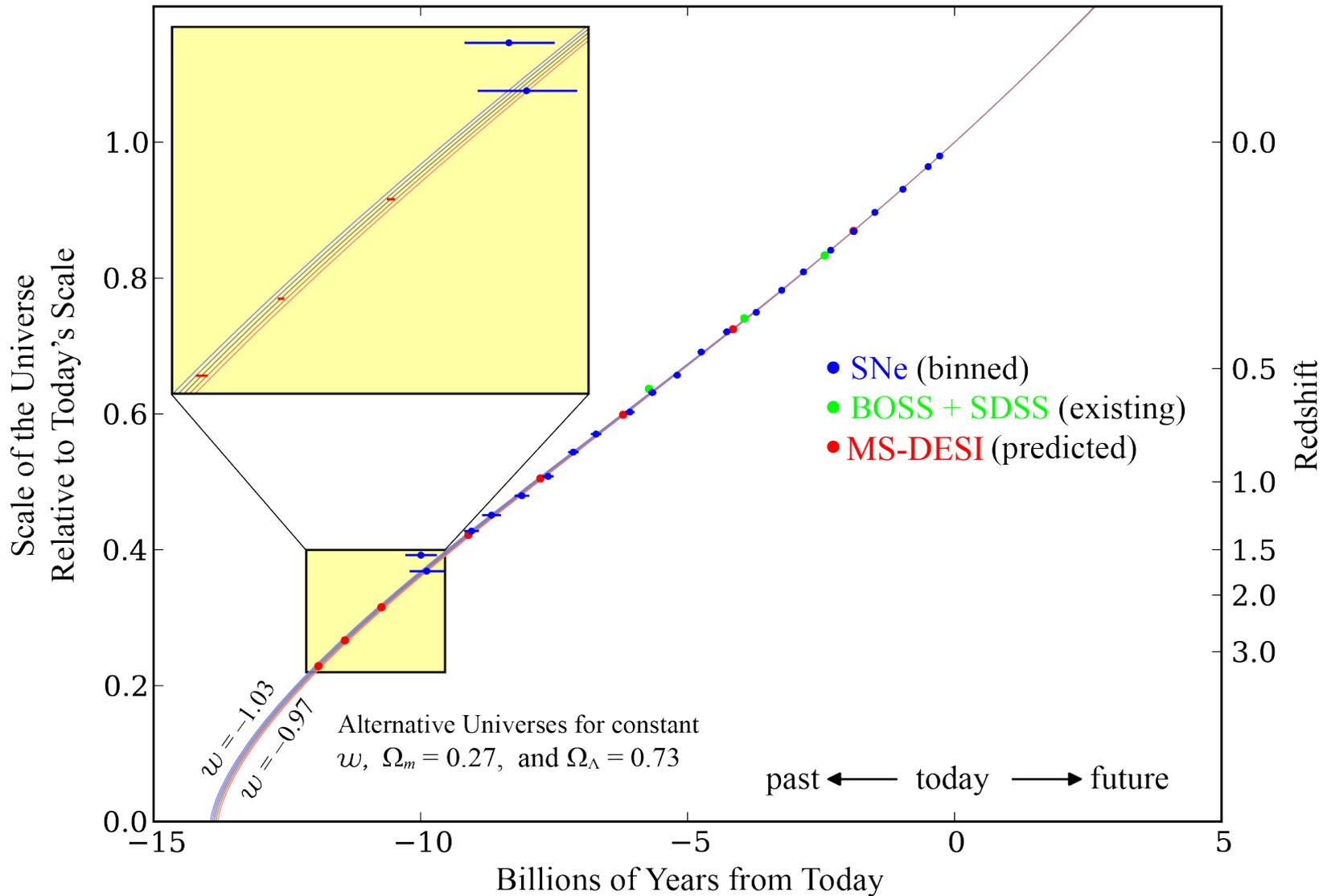
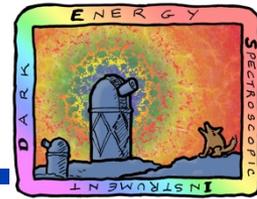
Michael Levi
APS-DPF UC Santa Cruz
August 16, 2013

DESI Overview

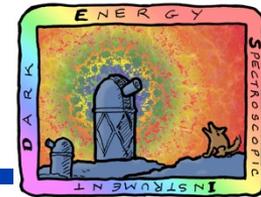


- **MS-DESI is the Mid-Scale Dark Energy Spectroscopic Instrument (DESI for short)**
- **Pioneering Stage-IV Experiment**
 - recommended by Community DE report (Rocky-III, 2012).
 - should fill the gap between DES and LSST
 - on sky before Euclid
- **MS-DESI meets this goal**
 - scientifically ambitious enough to satisfy Stage IV criteria
 - At least $x10$ more galaxies than BOSS
 - technically advanced enough to be ready on 2018 time frame
 - will be a statistically limited
 - rich scientific program: incl. DE, inflation, neutrino mass hierarchy

MS-DESI Will Discriminate Between Dark Energy Models



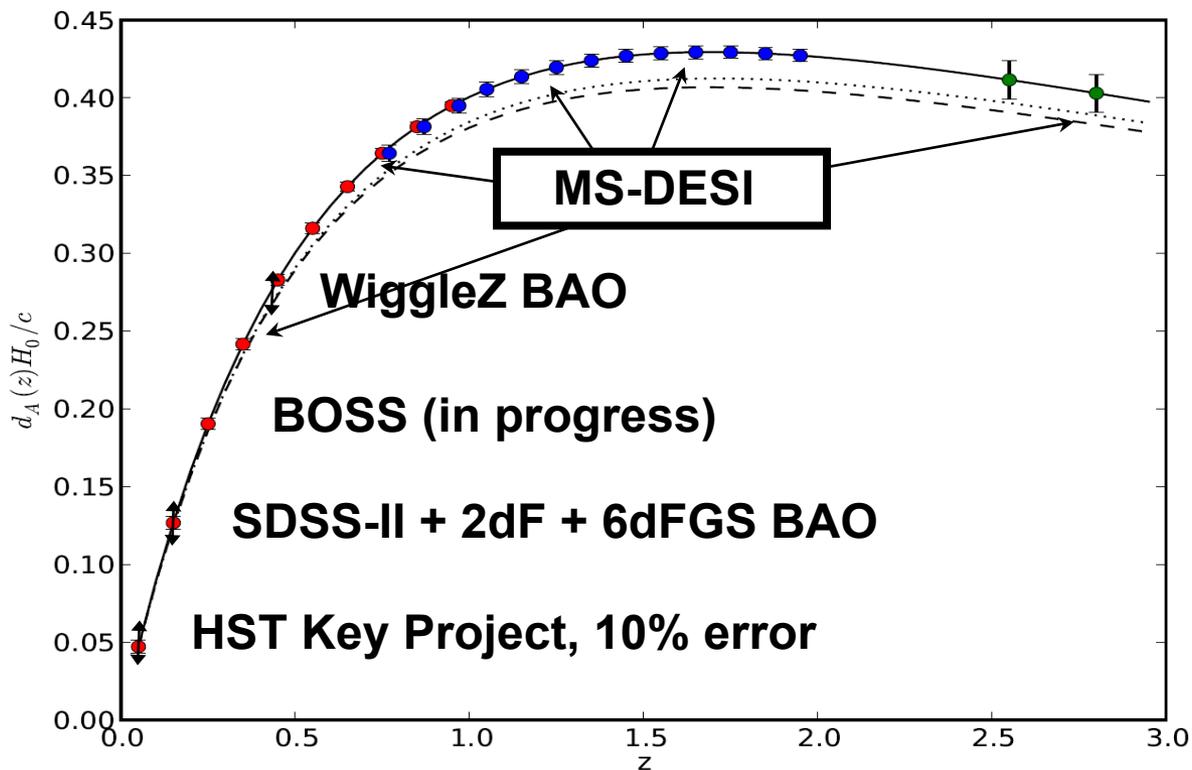
MS-DESI science reach: BAO



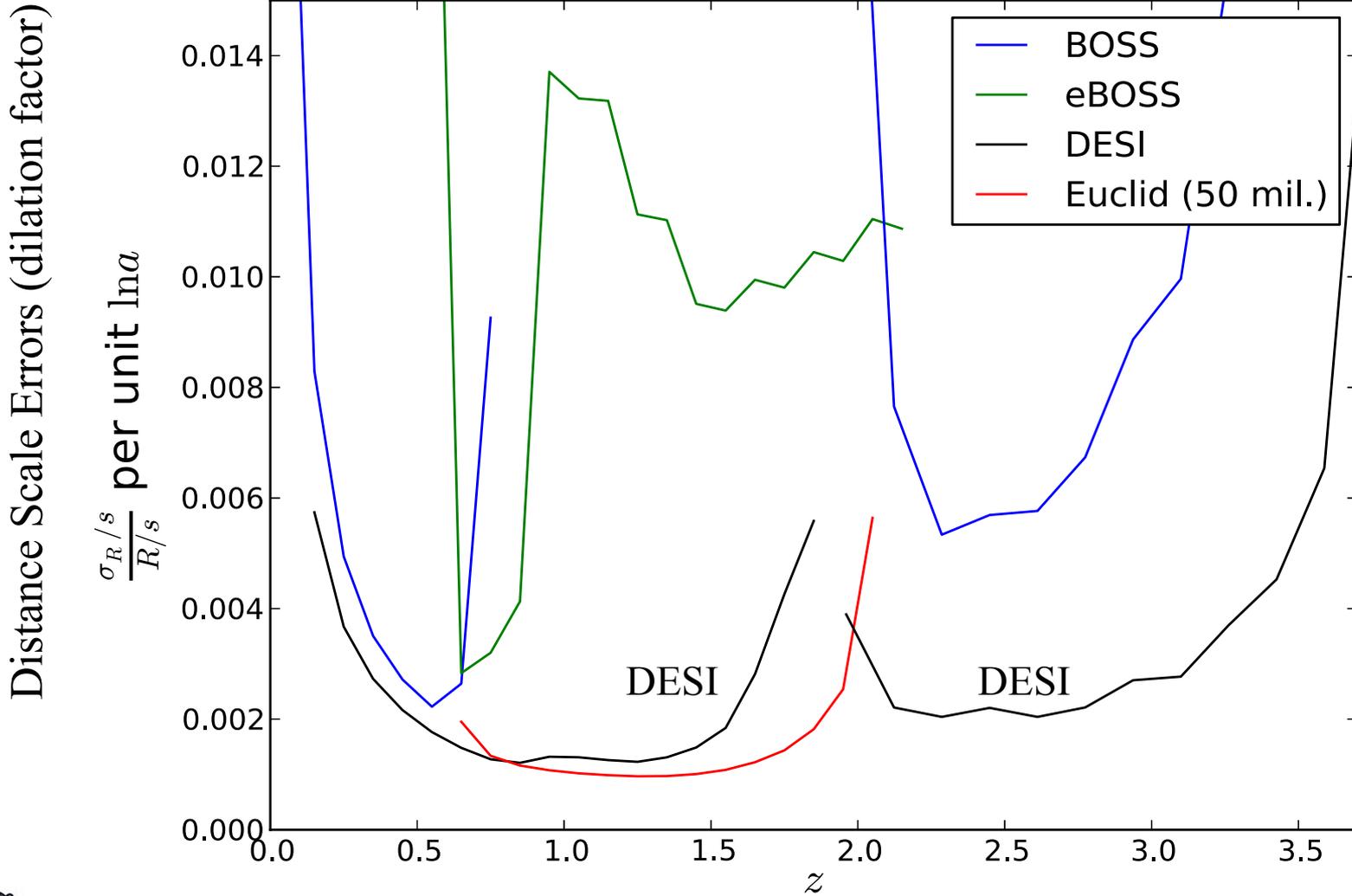
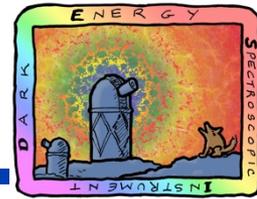
Dark energy from Stage IV BAO

- *Geometric probe with 0.3-1% precision from $z=0.5 \rightarrow 3$*
- *35 measurements with 1% precision*

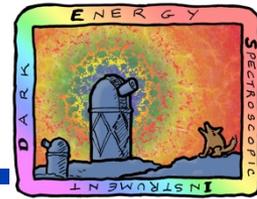
MS-DESI BAO “Hubble diagram”



DESI Compared to Current/Future Surveys



DESI Science reach: DE Figure of Merit

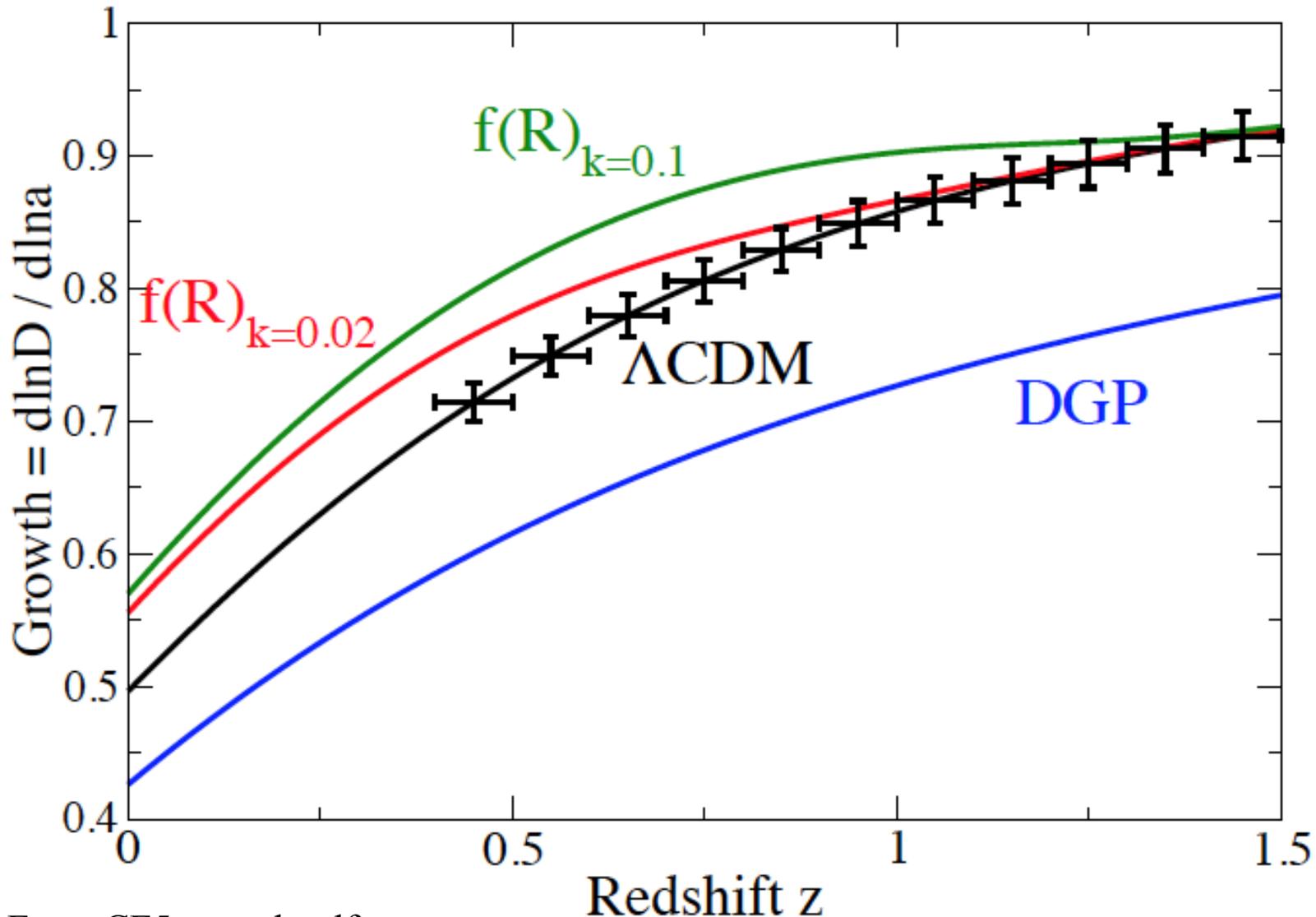
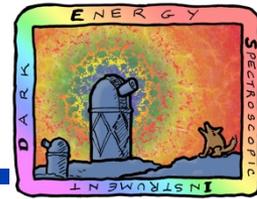


Survey Size	# Galaxy	Dark-time hours (KPNO)	BAO (galaxy + Ly- α) DE FOM	Add Power Spectrum DE FoM : MoG FoM	
BOSS	1.5M		21	22	41
MS-DESI 10K	17M	3750	104	149	1203
MS-DESI 14K	24M	5630	140	205	1497
MS-DESI 18K	32M	8100	174	261	1759
MS-DESI 14K-HD	40M	8100	187	267	1816

Table. All fits, Planck only. Broadband power for $k < 0.1$ h/Mpc. DE FOM is per DETF. MoG FoM = $1/(\sigma_y * \sigma_{G_9})$. With power spectrum, DE FoM is marginalized over MoG parameters. Ref: P. McDonald



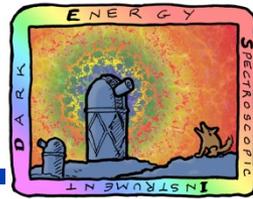
DESI - RSD Constraints on the growth of density fluctuations



From CF5 growth.pdf report

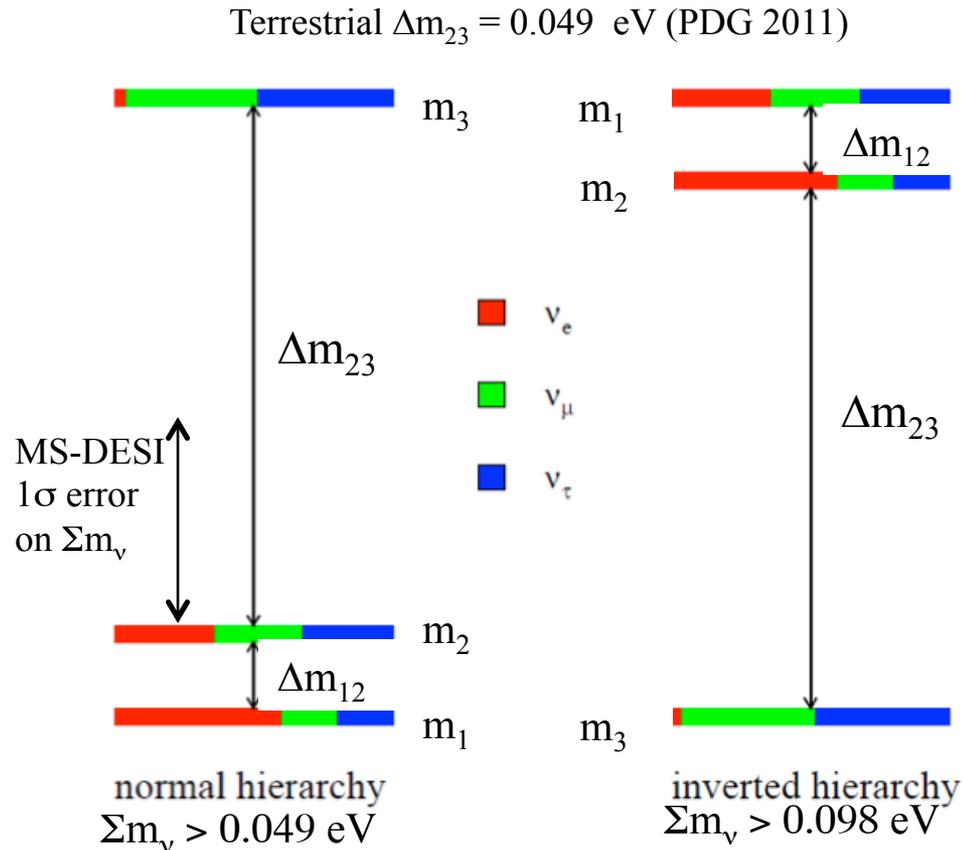


MS-DESI Science Reach: neutrino mass hierarchy

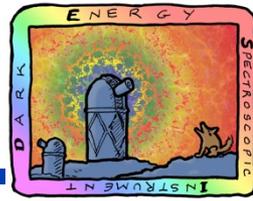


Terrestrial experiments measure Δm^2 of neutrino masses

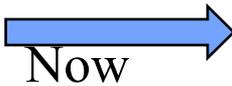
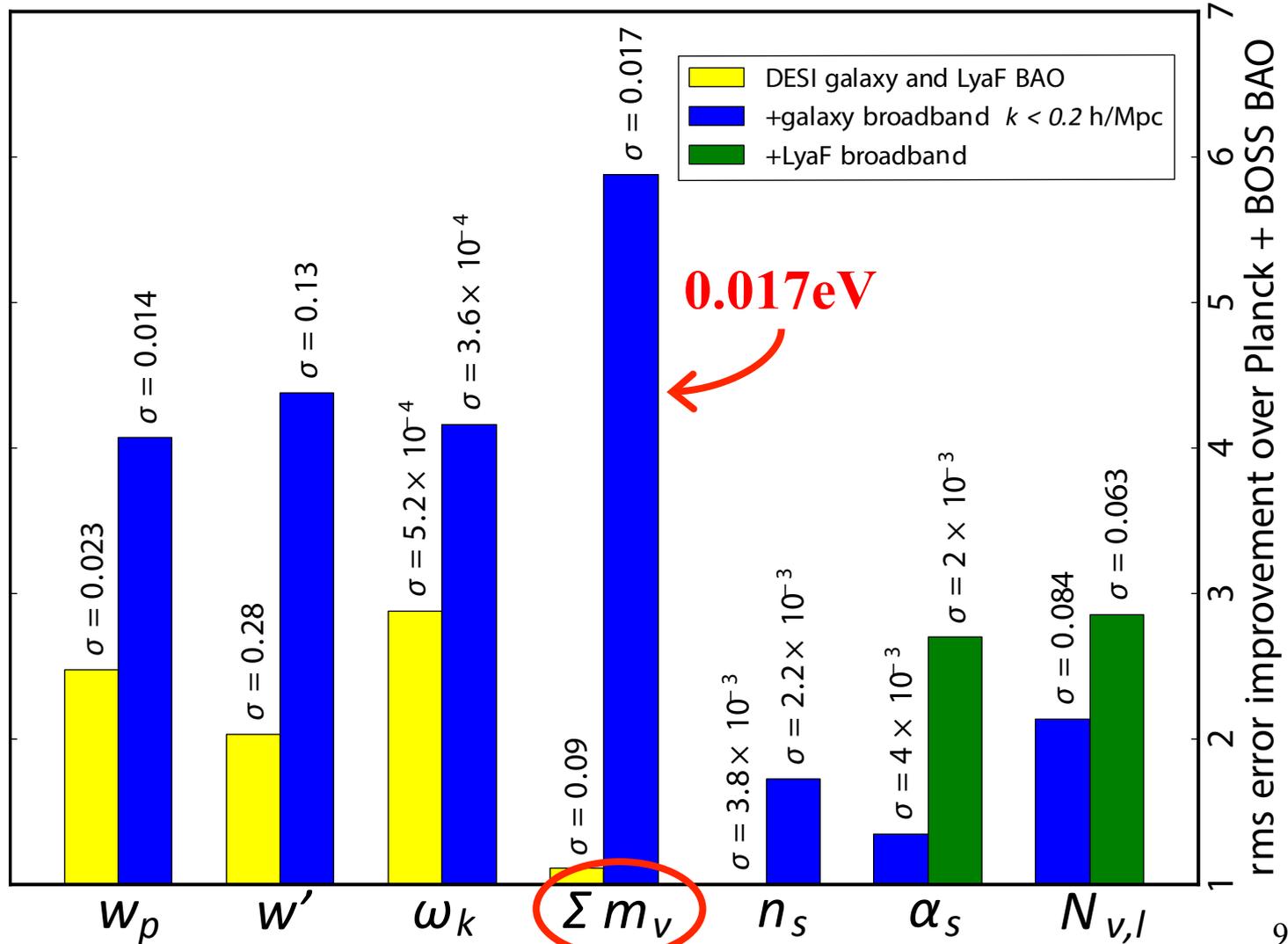
→ MS-DESI sensitivity is 0.017 eV , measured from power spectrum of galaxy map



Broad Scientific Goals



Improvement over Planck + BOSS (normalized to 1.0):



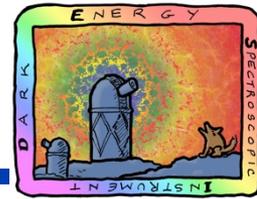
MS-DESI Status



- **The DOE Office of Science calls for a Mid-scale Dark Energy Spectroscopic Instrument (MS-DESI) experiment in September 2012.**
- **The new instrument to be operated in the 2018 - 2022 time period and perform Stage IV dark energy measurements.**
- **We have started the conceptual design phase of the project.**
- **Completed science alternatives analysis**
 - **Received charge from DOE on Feb 14 to compare science reach for 4-m telescopes at Kitt Peak, Arizona and Cerro Tololo, Chile**
- **DOE requested Mayall site from NSF as the preferred site**
 - **Mayall available with up to 100% of dark time, provides greater scientific potential.**
- **Established reference concept**
- **Conceptual design review scheduled for Jan, 2013**



MS-DESI Reference Concept

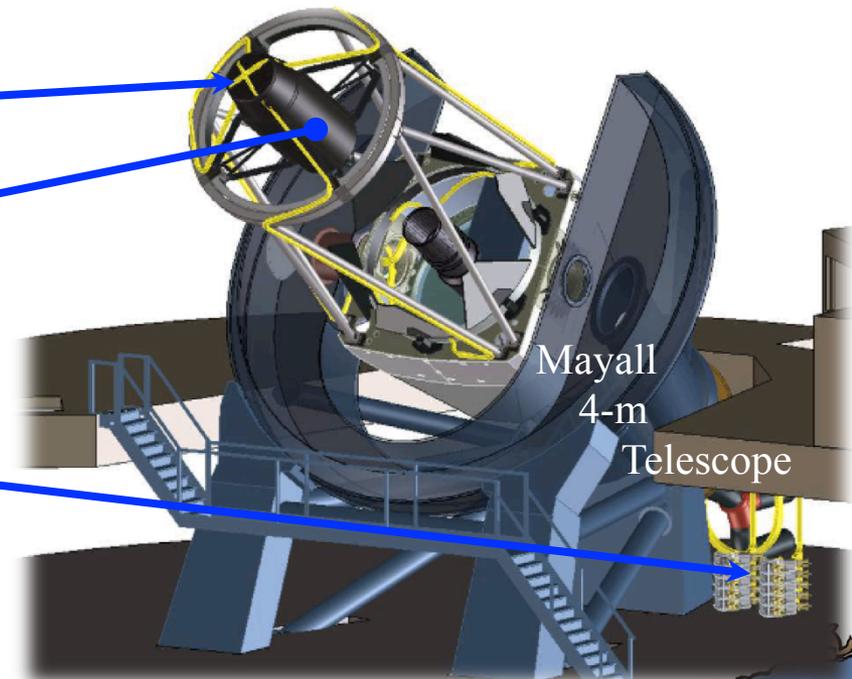


- Scale up BOSS to a massively parallel fiber-fed spectrometer
- Stage-IV BAO and Power Spectrum, build upon BOSS
- Broad range of target classes: LRG's, ELG's, QSO's
- Broad redshift range: $0.5 < z < 1.6$, $2.2 < z < 3.5$
- Sky area: 14,000 – 18,000 square degrees
- Number of redshifts: 20 – 35 million
- Medium resolution spectroscopy, $R \sim 3000 - 5000$
- Spectroscopy from blue to NIR
- Automated fiber system, $N_{\text{fiber}} \sim 4000 - 5000$

5000 fiber actuators

New 3° field-of-view corrector

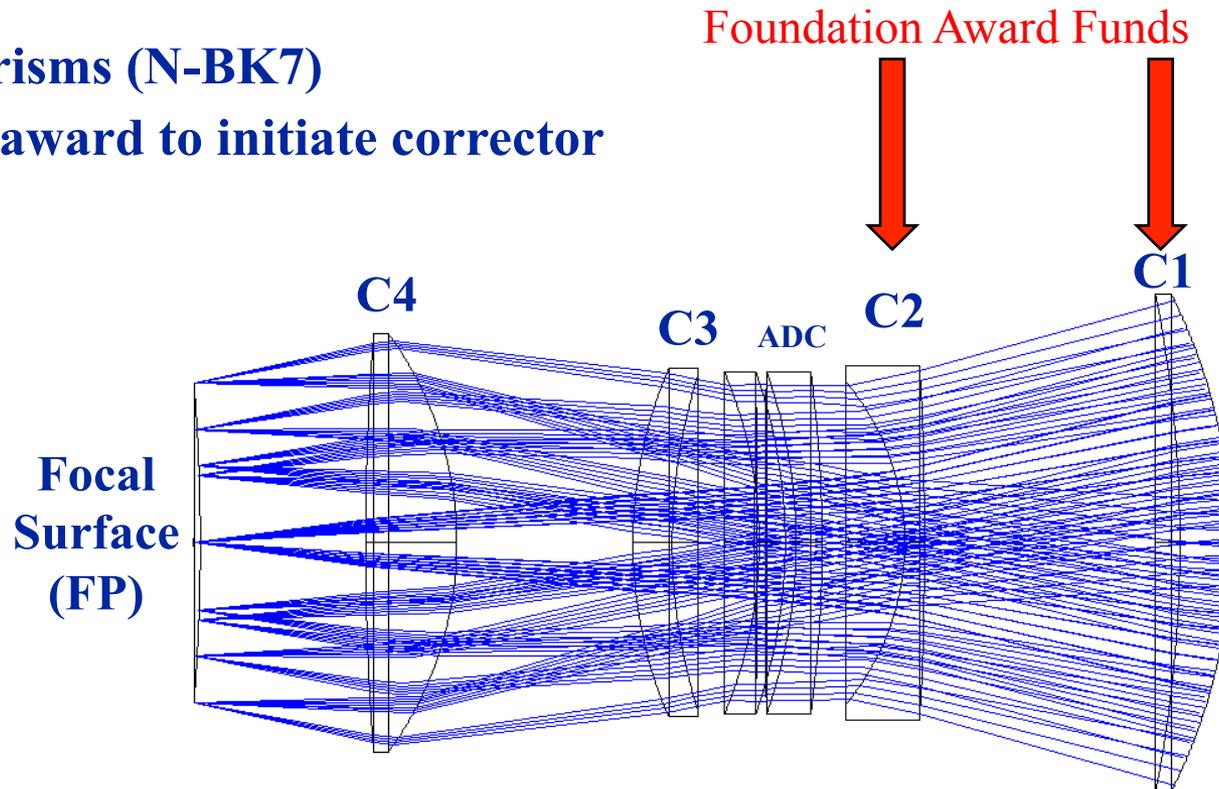
New spectrographs



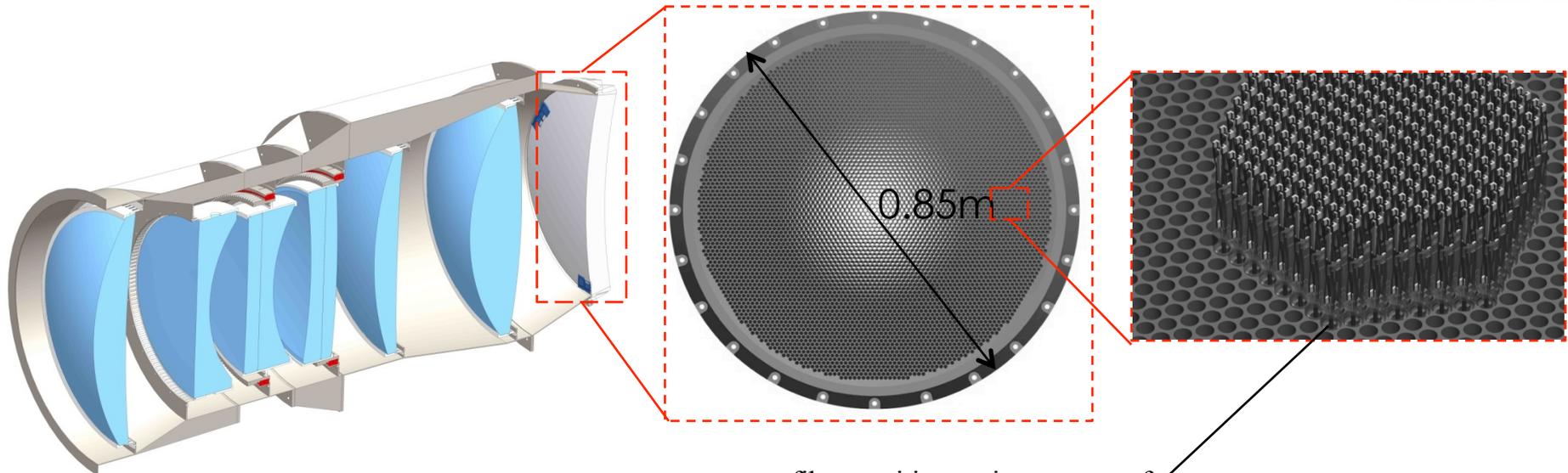
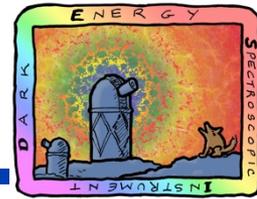
New Corrector for the Mayall



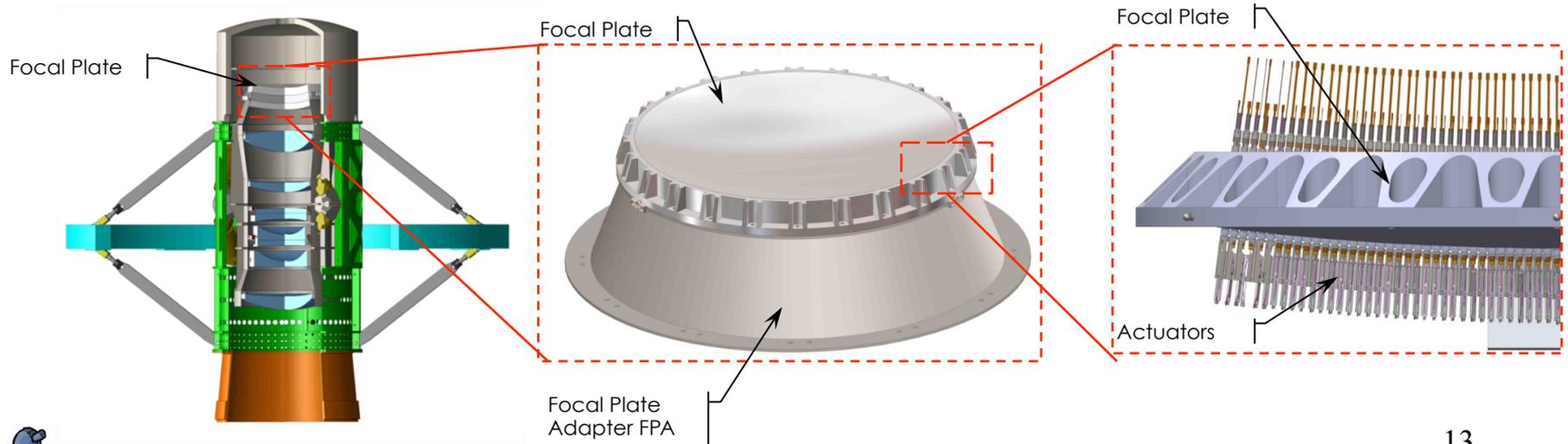
- M. Liang (NOAO)
- f/3.6 (Mayall Primary is f/2.9)
- ~900kg glass (3.2°)
- Four fused silica lens elements
- Two elements have aspheres on one surface each (C2 and C3)
- Two ADC prisms (N-BK7)
- Foundation award to initiate corrector



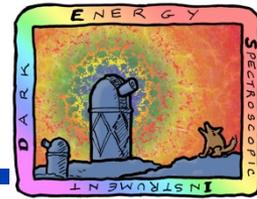
DESI Instrumentation



fiber positioners in an array of precision holes in the focal plate



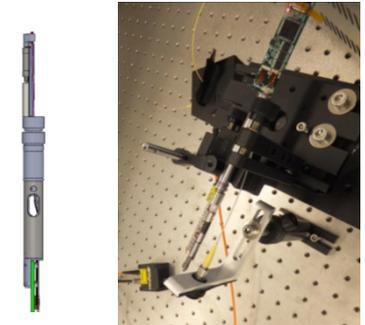
Actuator Development



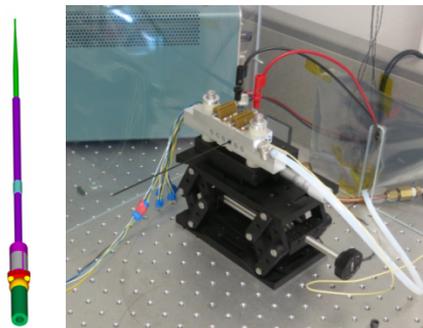
- **Actuator competition**
 - LBNL (Swiss) brushless motor
 - IAA stepper motor
 - AAO piezo
 - USTC stepper motor
- **Initial results suggest all actuators should be able to meet XY targeting goals**



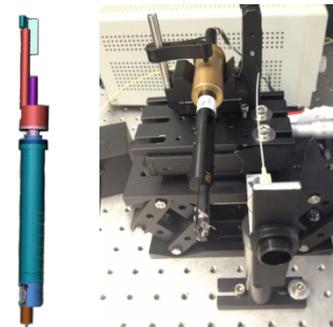
IAA 12mm



LBNL(swiss) 12mm



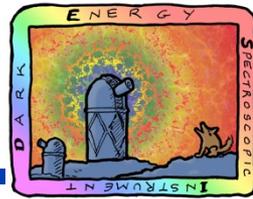
AAO 8mm



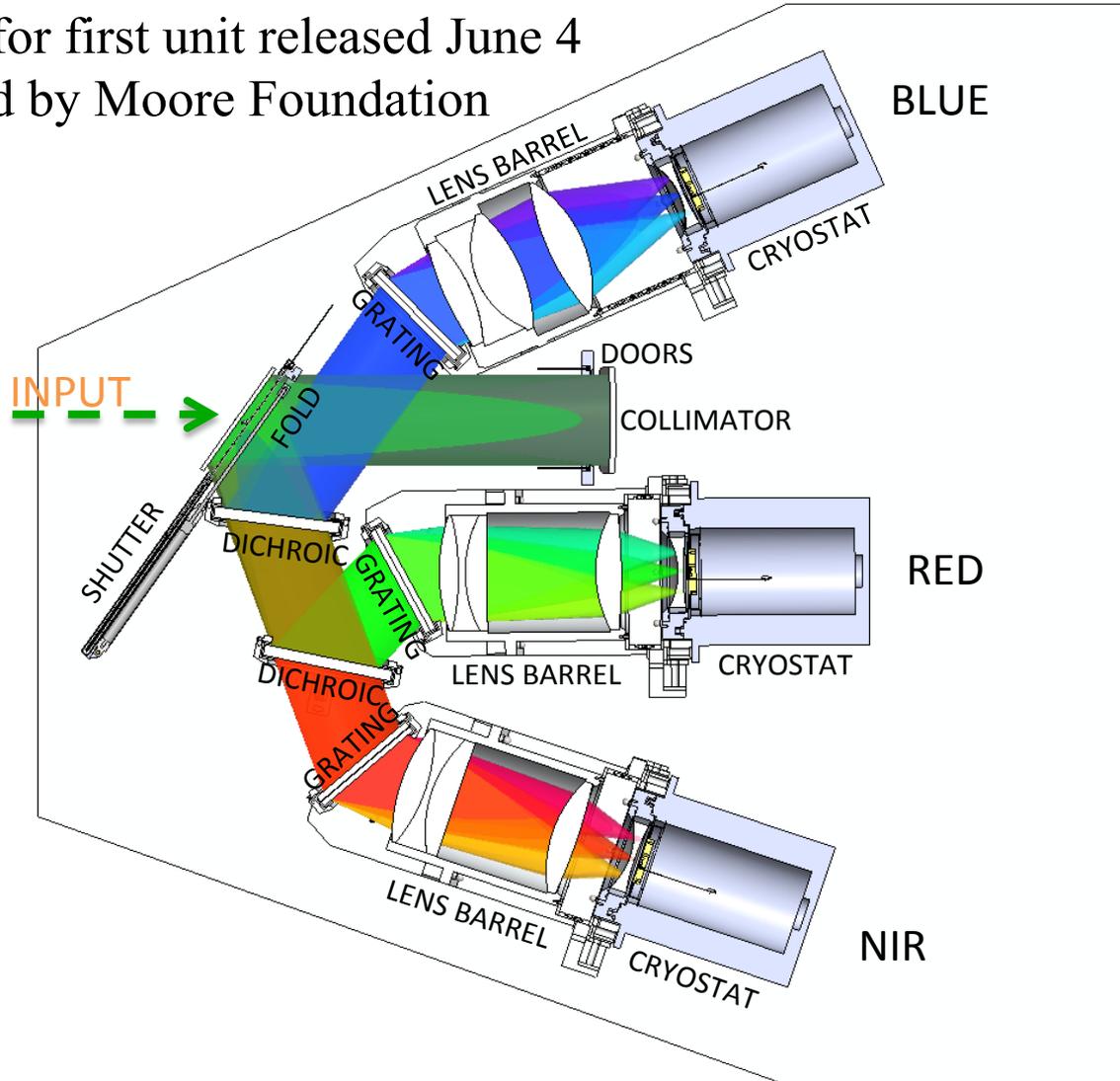
USTC 12mm



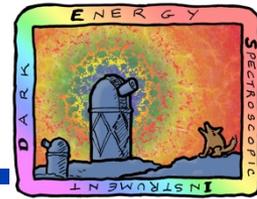
Spectrograph



Industry RFP for first unit released June 4
Unit #1 funded by Moore Foundation



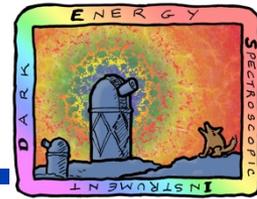
34 Current Institutions (and growing)



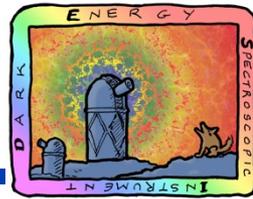
- AAO
- Argonne
- Brazil
- Brookhaven
- Carnegie Mellon Univ.
- Durham
- EPFL
- ETH Zurich
- FNAL
- Harvard
- IAA Spain
- Kansas
- KASI
- LAM/CPPM
- Mexico
- NOAO
- New York Univ.
- Portsmouth
- Saclay
- SJTU
- SLAC
- Spain
- Texas A&M
- The Ohio State Univ.
- Univ. College London
- UC Berkeley
- UC Irvine
- UC Santa Cruz
- U. Edinburgh
- U. Michigan
- U. Pittsburgh
- U. Utah
- USTC
- Yale



MS-DESI Meeting July 15, 2013



Conclusion



- **MS-DESI will have a rich science program**
 - scientifically ambitious enough to satisfy Stage IV criteria
 - rich scientific program: incl. DE, inflation, neutrino mass hierarchy
 - Expect to be in operation in 2018
- **Mayall selected as preferred site**
- **Gordon and Betty Moore Foundation Award**
 - Spectrograph RFP
 - Corrector glass limited-RFP in Fall
- **Conceptual design review by DOE, Jan 2014.**



Dark Energy Spectroscopic Instrument

